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(71) Applicant *(for all designated States except US)*: PARTEK CARGOTEC OY [FI/FI]; FIN-21600 Parainen (FI).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: SALMI, Teijo [FI/FI]; Haltianpolku 11 c 20, FIN-04440 Järvenpää (FI). SIREN, Sten [FI/FI]; Malmnäsintie 11, FIN-21600 Parainen (FI).

(74) Agent: OY KOLSTER AB; P.O. Box 148, Stora Robertsgatan 23, FIN-00121 Helsinki (FI).

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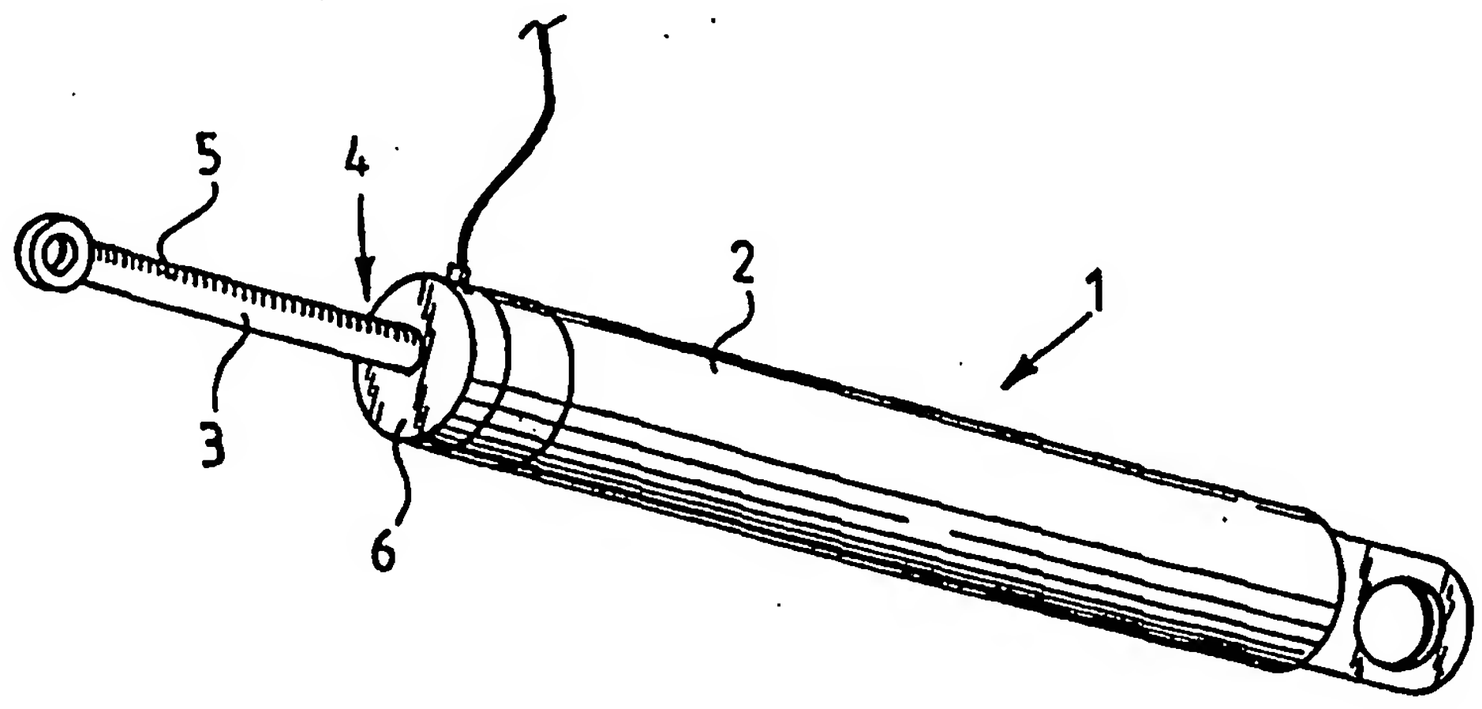
(54) Title: A HYDRAULIC, PNEUMATIC OR ANOTHER SIMILAR CYLINDER



(57) Abstract

The present invention relates to a hydraulic, pneumatic or another similar cylinder (1), comprising a cylinder sleeve (2) and a combination (3) of a piston and a piston rod arranged to move axially in the cylinder sleeve and means (4) for the determination of a position of the piston rod relative to the cylinder sleeve (2), which means consist of property variations (5) provided on the piston rod concerning a capability of the surface of the piston rod (3) of reflecting optical radiation and of a sensor (6) for detecting these property variations, which sensor (6) comprises at least one combination of a light source and a receiver. The property variations (5) on the piston rod have been provided according to the invention by means of a laser beam both efficiently and advantageously.

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A hydraulic, pneumatic or another similar cylinder

The present invention relates to a hydraulic, pneumatic or another similar cylinder, comprising a cylinder sleeve and a combination of a piston and a piston rod arranged to move axially in the cylinder sleeve and means for the determination of a position of the piston rod relative to the cylinder sleeve, which means consist of property variations provided on the piston rod concerning a capability of the surface of the piston rod of reflecting optical radiation and of a sensor for detecting these property variations, which sensor comprises at least one combination of a light source and a receiver.

A working cylinder as described above is known from German Offenlegungsschrift 3636730. According to that, optically readable marks are made on the surface of the piston rod by coating the rod with another material, such as copper, the optical properties of which differ sufficiently from the optical properties of the basic material of the rod, which in most cases is chrome. With these marks forming an increment scale, for instance, the position of the piston rod can be followed by an optical sensor. Such a known procedure for following the position of the piston rod has not become very general, however, the reason for which may be the great amount of work needed and the rather complicated equipment for providing the marks as well as the high costs due to the above facts. Problems may have occurred also as far as the endurance of the marks is concerned.

The object of the present invention is thus to set forth a novel solution especially for making marks on a piston rod, which solution is considerably more advantageous than the prior art solution and has

a better endurance and a better capability of giving information.

The above object has been achieved by means of a hydraulic, pneumatic or another similar cylinder according to the invention, which is characterized in that the property variations in the capability of the piston rod surface of reflecting optical radiation are provided by means of a laser beam. A laser beam makes it possible that the optical property variations forming an optically readable scale, which may contain absolute codes as well, if desired, are provided economically and effectively. When a chromated surface is treated by means of a laser beam, coloured areas, in practice even black areas, are formed thereon. Thanks to its colours, the treated area has reflecting properties different from the reflecting properties of the surrounding area. Accordingly, such marks are easily readable by means of an optical device. Since these marks, having a surface not projecting substantially from the remaining surroundings, are very wear-resistant, they do not wear even in long-term use to the extent so as to cause problems of reading them by means of an optical device.

In the following a cylinder according to the invention and optional structures thereof are described in more detail referring to the attached drawing, in which

Figure 1 shows a cylinder according to the invention,

Figure 2 shows a short portion of a piston rod of the cylinder of Figure 1,

Figure 3 shows an exemplifying embodiment of a scale made on the piston rod of the cylinder according to the invention in greater detail,

Figure 4 shows another embodiment of the scale

made on the piston rod in greater detail and

Figure 5 shows a block diagram of a sensor device for reading the scale illustrated in Figure 3.

Figure 1 shows a cylinder 1 according to the invention, comprising a cylinder sleeve 2 and a combination 3 of a piston and a piston rod arranged to move axially therein. Property variations 5 in the form of optically readable marks have been provided on the surface of this piston rod 3. Additionally, a reading device 6 is supported on the cylinder sleeve 2 for reading these marks made on the piston rod. The optical reading device is then positioned in a mechanically protected structure and it constitutes part of a sealing/bearing end piece of the cylinder. Both ends of the reading device 6 are provided with wipers (not shown) keeping the place to be read clean.

Figures 2 to 4 show exemplifying structure solutions for the scale to be provided on the surface of the piston rod 3 in more detail. These scales, which can naturally be formed entirely as desired, are realized by means of a laser beam in the way described above. Then the surface of the piston rod remains smooth, due to which it does not cause any extra wear on sealings or bearings. Moreover, a sufficient contrast can then be achieved between the metal surface and the marks so that the marks are readable by electro-optical readers. Marks provided by a laser beam are very hard and therefore endure the abrasive effect caused by the sealings and bearings very well.

The scale formed on the surface of the piston rod 3 can consist of a thread with a constant pitch all around the rod or of scale marks, as shown in Figures 2 to 4. The piston rods can thus be manufactured as longer integral portions, which are then cut

to finished piston rods. The separative power of a sensor is determined by a line space of the scale and by the number of optical readers. An increment sensor is provided in this way. Finding out the absolute position can be facilitated by placing absolute codes at fixed distances or on certain places on the rod. One such place is marked in Figure 3 in the form of a longer line. On the other hand, Figure 4 shows an absolute code 7, on the basis of which the position of the piston rod can be found out also when it is for some reason not possible to count the number of pulses starting from some extreme position, for instance, or from a place mark as shown in Figure 3 or if such an information has been lost in the meantime for some reason. The number of the used scales and used readers depends in practice on the need of each object of use for an accurate position information in particular, because by changing the number or breadth of the lines and, on the other hand, by increasing the number of readers, the reading accuracy can be improved.

Reading of marks provided on the piston rod takes place optically by means of a reflection sensor either by visible light or infrared light at a certain wavelength. Several combinations of a light source and a receiver suitable for this purpose are known in this field. It is preferable to choose for the used light a wavelength at which the scale is best discernible. Such a unity consisting of readers can be positioned, as shown in Figure 1, simply to form part of the end piece of the cylinder. The readers can naturally be positioned, depending on the case in question, also in a separate support structure outside the cylinder itself. Then the wipers of the piston rod cannot be positioned in connection

with the very readers, because they shall always be in mechanical contact with the piston rod itself so that the piston rod can be cleaned in a desired area to make the reading possible.

Figure 5 shows a block diagram of a sensor structure for reading the scale illustrated in Figure 3. This sensor comprises readers A, B and R, positioned around the piston rod 3 in such a manner that their reading points are situated at points X, Y and Z of Figure 3. Pulse sequences similar to those of Figure 5 are then obtained from these readers. The reader itself comprises a light source and a light receiver receiving the light reflected from the scale of the piston rod. After this the signals changed into electric signals by the receivers are digitized in blocks 8, whereby pulse sequences similar to those shown in Figure 5 are obtained. By comparing the pulse sequences given by the readers A, B and R with each other, a certain absolute position on the piston rod is firstly found out by means of the pulse sequence R and, on the other hand, the number of pulses, i.e. the distance from the position of the absolute mark, and the direction of motion of the piston rod are found out by means of the pulses A and B. Besides, because the pulse length of the pulses A and B corresponds to the time during which the mark passes the reader, it is possible to determine the speed of motion of the piston rod on the basis of the length of these pulses. In the block diagram of Figure 5, a from-edge-to-edge sensor 9 for the pulses A and B is provided for this measure, which sensor determines the length of the pulse, and a pulse length voltage transducer 10 is provided for transducing this pulse length to a voltage value. As an output of the transducer 10 is obtained a voltage, which can be

for instance in the area 0 to 5 V and which is directly proportional to the speed of the piston rod.

Figure 4 shows an exemplifying alternative to the scale illustrated in Figure 3, in which an absolute code (for instance figure 20) is provided by means of the marks 7, by means of which code the reader can read the absolute position of the piston rod directly as a numerical code.

Above the cylinder of the invention has been described by means of one exemplifying embodiment only and it is understandable that numerous alterations can be made therein without differing from the scope of protection defined by the attached claims, however. Accordingly, as mentioned above, the shapes of the scales can vary even very arbitrarily. The most significant advantage of the cylinder according to the invention is that the scale marks are very hard and wear-resistant even in the simplest implementation, but do not, however, cause any changes in the surface of the piston rod, as far as its use expressly as a piston rod is concerned.

Claims:

1. A hydraulic, pneumatic or another similar cylinder (1), comprising a cylinder sleeve (2) and a combination (3) of a piston and a piston rod arranged to move axially in the cylinder sleeve and means (4) for the determination of a position of the piston rod relative to the cylinder sleeve (2), which means consist of property variations (5) provided on the piston rod concerning a capability of the surface of the piston rod (3) of reflecting optical radiation and of a sensor (6) for detecting these property variations, which sensor (6) comprises at least one combination of a light source and a receiver, c h a r a c t e r i z e d in that the property variations (5) in the capability of the piston rod (3) surface of reflecting optical radiation are provided by means of a laser beam.

2. A cylinder according to claim 1, c h a r a c t e r i z e d in that the property variations (5) provide an optically readable scale on the surface of the piston rod.

3. A cylinder according to claim 2, c h a r a c t e r i z e d in that the scale comprises absolute codes (7).

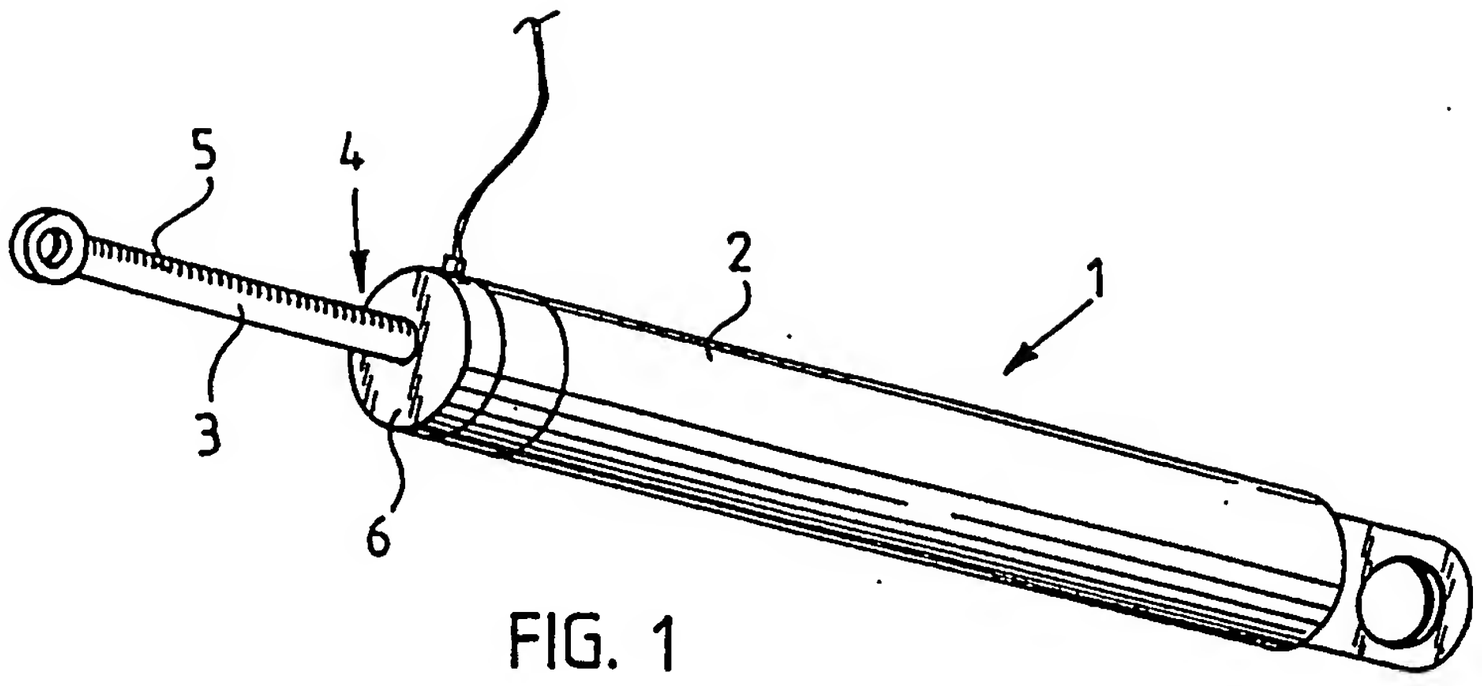

FIG. 1

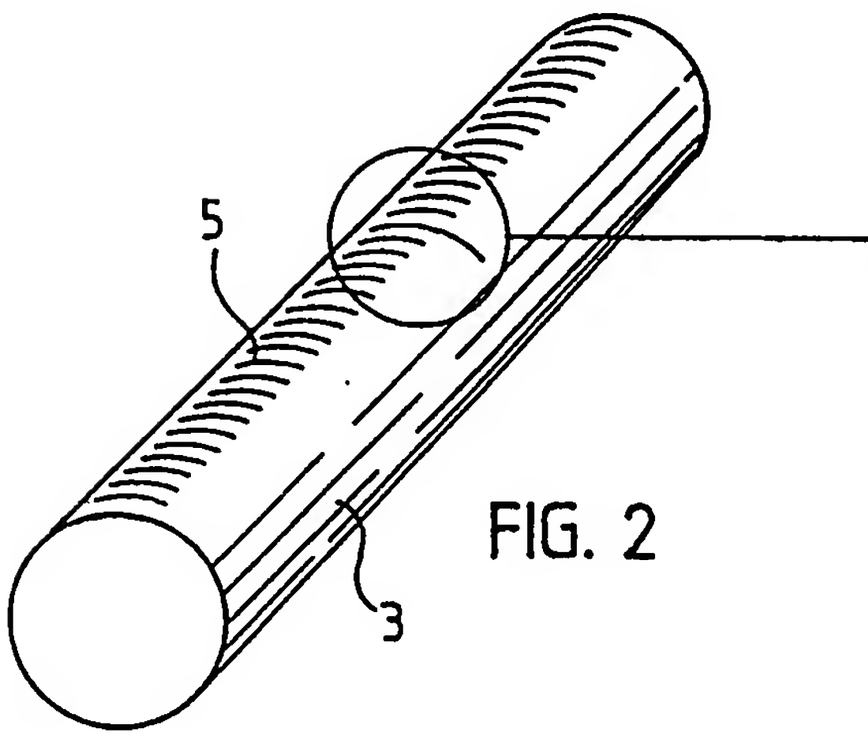

FIG. 2

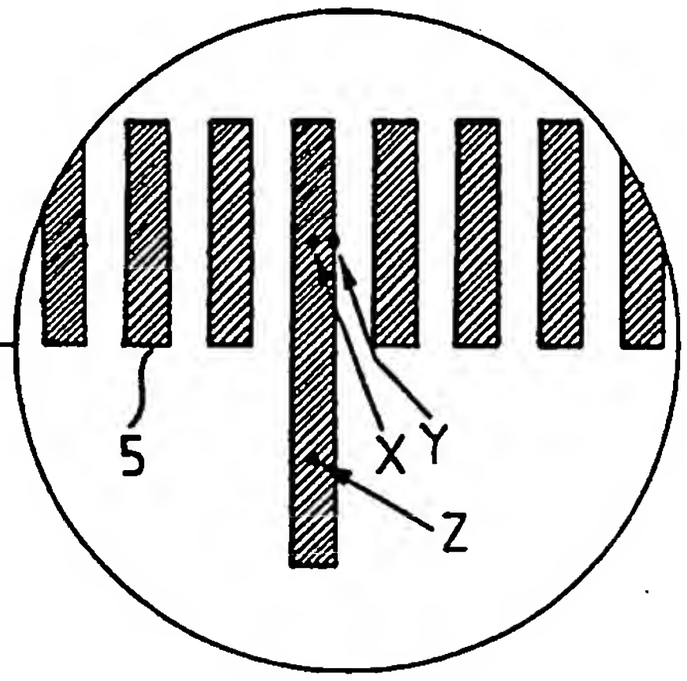

FIG. 3

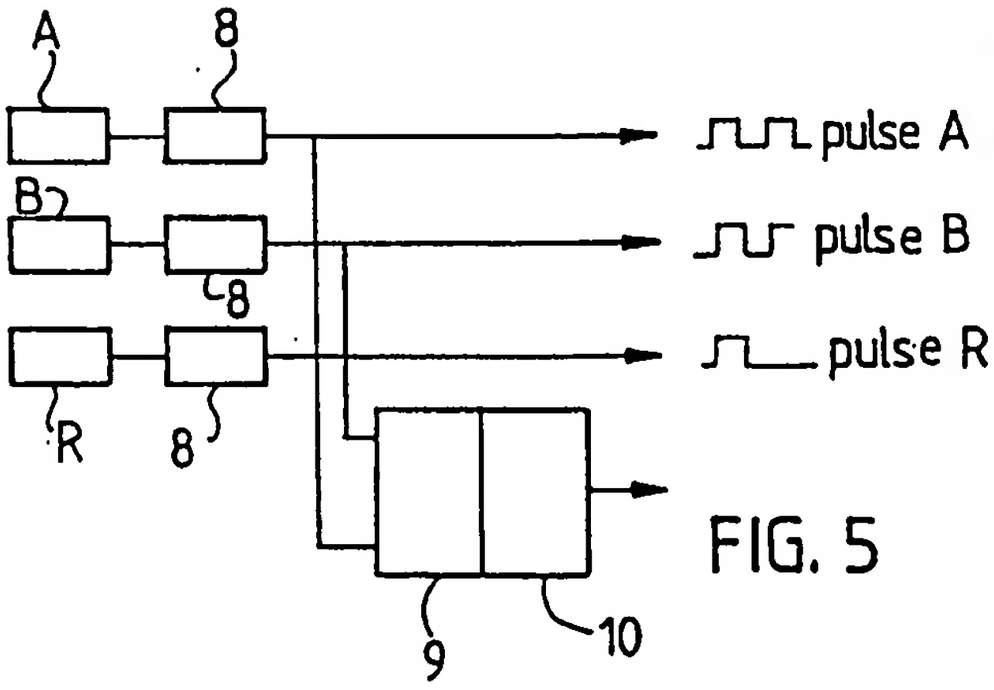

FIG. 5

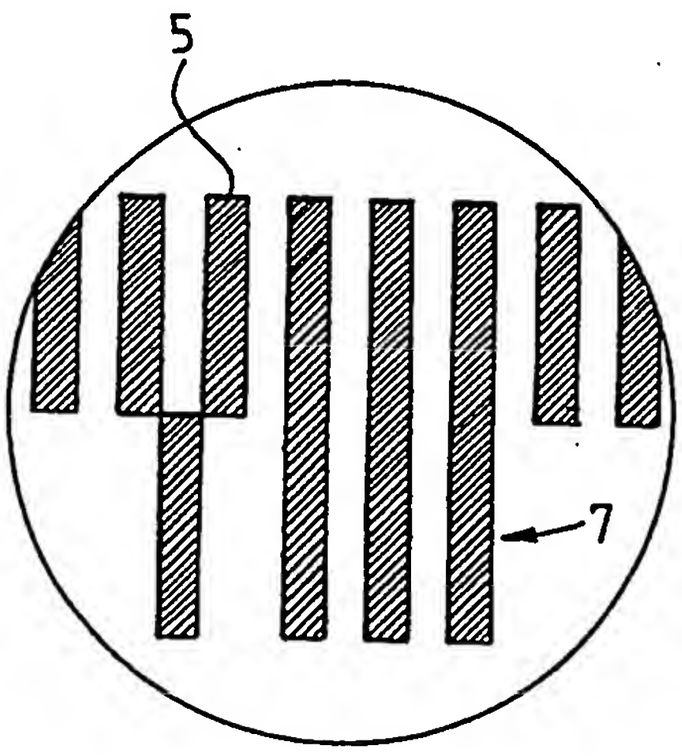

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 93/00285

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: F15B 15/28
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: F15B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4756229 (DRAKELEY), 12 July 1988 (12.07.88) --	1-3
Y	EP, A1, 0296808 (PARKER HANNIFIN CORPORATION), 28 December 1988 (28.12.88) --	1-3
A	DE, A1, 3634730 (HüGLER, KLAUS), 21 April 1988 (21.04.88) --	1-3
Y	OPTICAL INGINEERING, Vol. 19, No. 5, September/ October 1980, pages 783-792; D.S. GNANAMUTHU: "Laser surface treatment" -- -------	1-3

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A- 4756229	12/07/88	NONE	
EP-A1- 0296808	28/12/88	CA-A- 1282139	26/03/91
		DE-A- 3868714	09/04/92
DE-A1- 3634730	21/04/88	NONE	